On the Direction and Velocity of the Motion of the Sun, and Solar System. *By* William Herschel, *LL.D. F.R.S.* Read May 16, 1805. [*Phil. Trans.* 1805, *p.* 233.]

Although, in the title to this paper, Dr. Herschel mentions both the direction and velocity of the solar system, it is his intention, he says, to limit his inquiries, at present, to the first of these subjects, and to discuss the other at some future opportunity. He is induced to enter into this inquiry, because a solar motion, if established, seems to contradict the original intention for which it was introduced; namely, to take away many of the proper motions of stars, by investing the sun with a contrary one. But as the solar motion will reveal a greater number of concealed real motions than need be admitted if the sun were at rest, the necessity of admitting its motion ought to be well established.

From the motion of the secondary planets round the primary ones, and of these round the sun, the solar motion must be allowed to be a very possible event; and the rotatory motion of the sun, from which a displacing of the solar centre has been inferred, also indicates a motion of translation in space; for it does not appear probable that any mechanical impression should produce the former without occasioning the latter.

It would, Dr. Herschel thinks, be worth while for those who have fixed instruments, to observe those stars which change their magnitudes periodically; for, as this change is probably owing to a rotatory motion, a real motion in space may be expected to attend it: and, on the other hand, all those stars that have a motion in space may be supposed to have also a rotation on their axes.

Dr. Herschel now proceeds to consider the symptoms of parallactic motions. If, says he, the sun be supposed to move towards a certain part of the heavens, the stars will appear, to an inhabitant of the earth, to move in an opposite direction. This may be called the parallactic motion of a star; and, if the star has no real motion, it will also be its apparent motion; but, if the star should have a real motion, it will appear to move along the diagonal of a parallelogram, which diagonal will represent its real motion. This is illustrated by a diagram, to which we must refer for a fuller explanation of this part of the paper. We shall only observe, that the absolute motion of a star in space will still remain unknown, as well as its velocity, because the inclination of that motion, on which its real velocity will depend, admits the greatest variety of directions.

In order to ascertain whether parallactic motions exist, we ought, Dr. Herschel says, to examine the brightest stars; it being probable that they are most liable to be visibly affected by solar motion: and we should also seek for a criterion by which parallactic motions may be distinguished from real motions. This we find in their directions; for, if a solar motion exists, all parallactic motions will tend to a point in opposition to its direction; whereas real motions will be dispersed indiscriminately to all parts of space.

Dr. Herschel has delineated the meeting of the arches, arising from a calculation of the proper motions of the 36 stars in Dr. Maskelyne's Catalogue, on a celestial globe; and finds that, in the northern hemisphere, no less than ten of those intersections are made by stars of the first magnitude, in a very limited part of the heavens, about the constellation of Hercules. Upon all the remaining surface there is not the least appearance of any other than a promiscuous situation of intersections, and only one of these made by arches of principal stars.

A table is then given of the calculated situations of the above-mentioned ten intersections in right ascension and north polar distance; and it is observed, that if the intersections made by the proper motions of some large stars of the next order, and the arches in which the stars of the first magnitude move, are examined, no less than fifteen unite with the former ten in pointing out the same part of the heavens as a parallactic centre. This, Dr. Herschel thinks, can hardly fail to be considered as a convincing proof of the motion here treated of.

The changes in the position of double stars are next considered; and these, Dr. Herschel thinks, it will be more eligible to ascribe to the effect of parallax than to admit so many separate motions in the different stars, especially as the parallactic motions of at least half of the 56 double stars described by him, point out the same apex of a solar motion by their direction to its opposite parallactic centre.

Dr. Herschel then remarks, that if the proper motions of the stars were such as they appear to be, they would exhibit an incongruous mixture of great velocity and extreme slowness. Of this incongruity, several instances are enumerated; but it will, he says, be shown, when the direction and velocity of the solar motion are explained, that these incongruities are mere parallactic appearances.

With respect to the occultation of a small star by a large one, Dr. Herschel will, he says, prove, when the solar motion is established, that the vanishing of the small star near δ Cygni is, as far as we can judge at present, only a parallactic appearance.

Dr. Herschel now proceeds to consider the direction of the solar motion; the expedience of admitting such motion being, he thinks, after what has been said, no longer questionable.

He begins by proving, that when the proper motions of two stars are given, an apex may be found, to which, if the sun be supposed to move with a certain velocity, the two given motions may be resolved into apparent changes, arising from sidereal parallax; the stars remaining perfectly at rest. The mode of proving this, in which Arcturus and Sirius are used as examples, will not admit of abridgement. But, from the nature of proper motions, it follows, that when a third star does not lead us to the same apex as the other two, its apparent motion cannot be resolved by the effect of parallax alone: and, although we may account for the proper motion of the third star, Capella for instance, by retaining the same apex of the solar motion which explained the apparent motions of the other

two, yet, in doing this, we must assign a high degree of real motion to Capella. To this it may be objected, that we have no reason to deprive Arcturus and Sirius of real motions, in order to give a motion of the same nature to every star that has a proper motion not tending to the same parallactic centre as the motions of Arcturus and Sirius.

It appears, therefore, that such an apex for the solar motion ought to be fixed upon as is equally favourable to every star that is proper for directing our choice; and our aim must be, to reduce the proper motions of the stars to their lowest quantities.

From a table given by Dr. Herschel, it appears, that the sum of the apparent motions of the six principal stars whose intersecting arches are given, namely, Sirius, Arcturus, Capella, Lyra, Aldebaran, and Procyon, is $5''{\cdot}353$; and if we suppose the point towards which the sun moves to be λ Herculis, the annual proper motions of the six stars will be reduced to real motions of no more than $2''{\cdot}219$.

It appears, from the inspection of a figure that represents the quantities of real motion required when λ Herculis is fixed upon, that, by a regular method of approximation, a situation might be found where the apparent motion of the six stars would be much reduced. Accordingly, by fixing upon a point near the following knee of Hercules, whose right ascension is $270°\ 15'$, and north polar distance $54°\ 45'$, the annual proper motion of the six stars was reduced to $1''{\cdot}459$, which is $0''{\cdot}760$ less than when the apex was λ Herculis.

In approximating to the above point, the line of the apparent motion of Sirius was principally considered; but, as Sirius is not the star that has the greatest proper motion, it occurred to Dr. Herschel that another minimum, obtained from the line in which Arcturus seems to move, would be more accurate; and he was soon led to a point, not only in the line of the apparent motion of Arcturus, but equally favourable to Sirius and Procyon, the remaining two stars that have the greatest motion. The right ascension of this point is $245°\ 52'\ 30''$, and its north polar distance $40°\ 22'$.

If the principles which have been laid down for determining the solar motion are admitted, the above apex must be very near the truth; for an alteration of a few minutes in right ascension or polar distance, either way, will increase the required real motion of these stars. The sum of the real motions with the before-mentioned apex is only $\cdot 859$, being less than that of the former calculation by $\cdot 599$.

Dr. Herschel does not, he says, mean to assert that these real motions can be actually reduced to the low quantities above mentioned; but, whatever may be the sum of real motions required to account for the phenomena of proper motions, the foregoing arguments cannot be affected by the result; for, as it is known that proper motions exist, and no solar motion can resolve them entirely into parallactic motions, we ought to give the preference to that direction of the motion of the sun that will take away more real motion than any other.